US009097581B2

(12) United States Patent
Fujiwara

(10) Patent No.: US 9,097,581 B2
(45) Date of Patent: Aug. 4, 2015

(54) PYROELECTRIC INFRARED DETECTING DEVICE, AND METHOD FOR REPLACING PYROELECTRIC ELEMENT IN PYROELECTRIC INFRARED DETECTING DEVICE

(75) Inventor: **Shigemi Fujiwara**, Sendai (JP)

(73) Assignee: **NEC TOKIN CORPORATION**, Sendai-shi, Miyagi (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 150 days.

(21) Appl. No.: **13/825,798**

(22) PCT Filed: **Sep. 20, 2011**

(86) PCT No.: **PCT/JP2011/071329**
§ 371 (c)(1),
(2), (4) Date: **May 31, 2013**

(87) PCT Pub. No.: **WO2012/039374**
PCT Pub. Date: **Mar. 29, 2012**

(65) **Prior Publication Data**

US 2013/0234026 A1 Sep. 12, 2013

(30) **Foreign Application Priority Data**

Sep. 24, 2010 (JP) 2010-213760

(51) **Int. Cl.**
G01J 5/34 (2006.01)
G01J 5/02 (2006.01)
G01J 1/04 (2006.01)

(52) **U.S. Cl.**
CPC ***G01J 5/34*** (2013.01); ***G01J 1/0403*** (2013.01); ***G01J 5/023*** (2013.01); ***G01J 5/024*** (2013.01); ***G01J 5/0205*** (2013.01); ***G01J 5/0225*** (2013.01)

(58) **Field of Classification Search**
CPC G01J 5/34
USPC 250/338.3, 349; 445/2
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,542,294 A * 9/1985 Tamura et al. 250/338.3
5,423,931 A 6/1995 Inoue et al.

(Continued)

FOREIGN PATENT DOCUMENTS

CN 1085012 A 4/1994
CN 1144331 A 3/1997

(Continued)

OTHER PUBLICATIONS

International Search Report (with English translation) issued on Nov. 8, 2011, in International Application No. PCT/JP2011/071329.

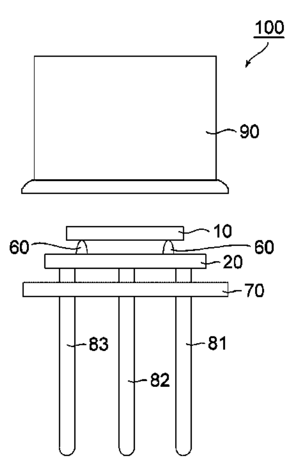
(Continued)

Primary Examiner — David Porta
Assistant Examiner — Meenakshi Sahu
(74) *Attorney, Agent, or Firm* — Holtz, Holtz, Goodman & Chick PC

(57) **ABSTRACT**

While conductive adhesives **60** are provided between element electrodes of a pyroelectric element **10** and board electrodes of an installation board **20**, the conductive adhesives **60** are hardened to connect between the element electrodes of the pyroelectric element **10** and the board electrodes of the installation board **20**. The conductive adhesives **60** include epoxy resin and, after hardened, have 4B to 7H, both inclusive, of pencil hardness as their hardness on JIS K 5600-5-4 (ISO 15184) standard basis. If the pyroelectric element **10** is broken down, the hardened conductive adhesives **60** are impacted or are cut by using a cutter to take off the pyroelectric element **10** from the installation board **20**.

8 Claims, 8 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

6,186,848	B1 *	2/2001	Yotsumoto et al.	445/2
2002/0175285	A1 *	11/2002	Ito et al.	250/338.3
2005/0279939	A1 *	12/2005	Yoshida et al.	250/332
2009/0050808	A1 *	2/2009	Ushimi et al.	250/338.3
2010/0183887	A1 *	7/2010	Krienke	428/447

FOREIGN PATENT DOCUMENTS

EP	0 736 911	A2	10/1996
JP	06-331438	A	12/1994
JP	07-092025	A	4/1995
JP	07092025	*	4/1995
JP	08-278196	A	10/1996
JP	09-126879	A	5/1997
JP	10-038679	A	2/1998
JP	11-064105	A	3/1999
JP	2001-304957	A	10/2001
JP	2003-069378	A	3/2003
JP	2008-268052	A	11/2008
JP	2010-169520	A	8/2010
WO	WO 2007/129547	A1	11/2007

OTHER PUBLICATIONS

Chinese Office Action dated Aug. 21, 2014 issued in counterpart Chinese Application No. 201180045041.7.

Japanese Office Action dated Mar. 5, 2015, issued in counterpart Japanese Application No. 2012-535028.

Taiwanese Office Action dated Mar. 4, 2015, issued in counterpart Taiwanese Application No. 100134207.

* cited by examiner

FIG. 1

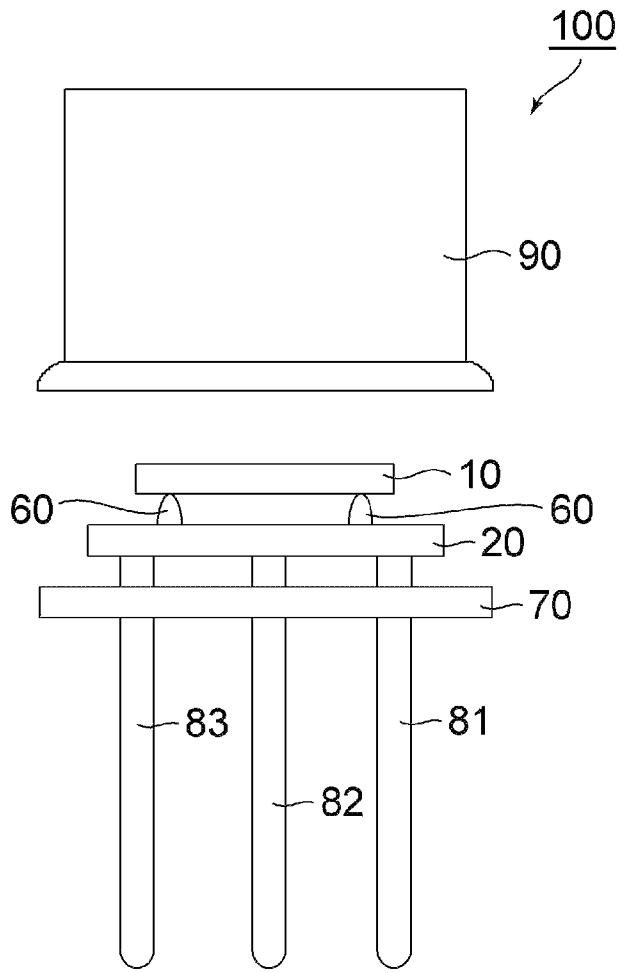


FIG. 2

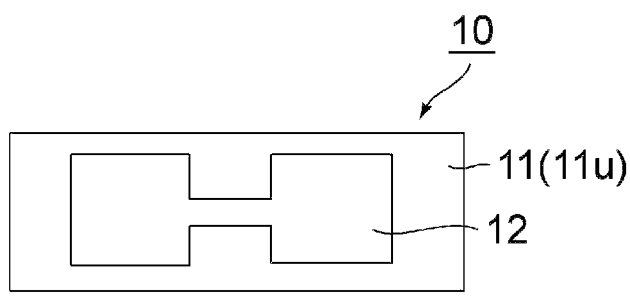


FIG. 3

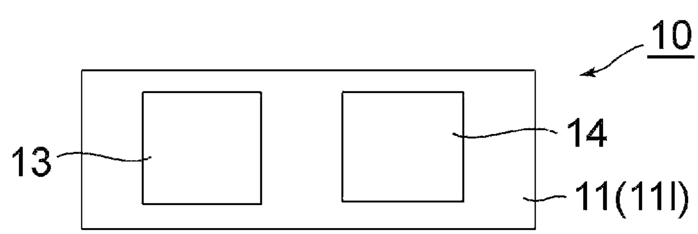


FIG. 4

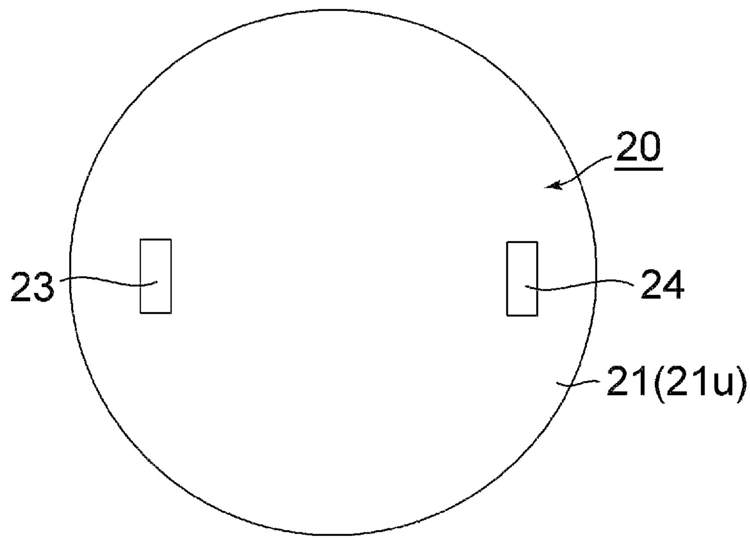


FIG. 5

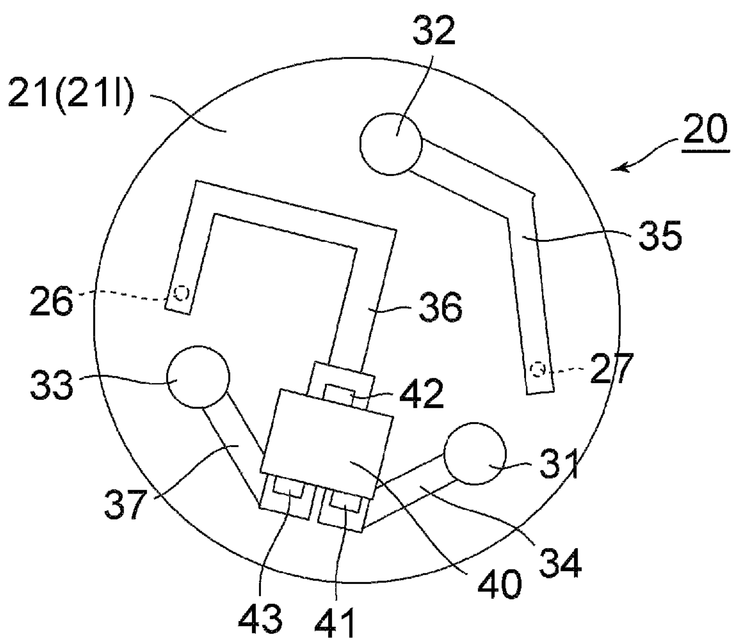


FIG. 6

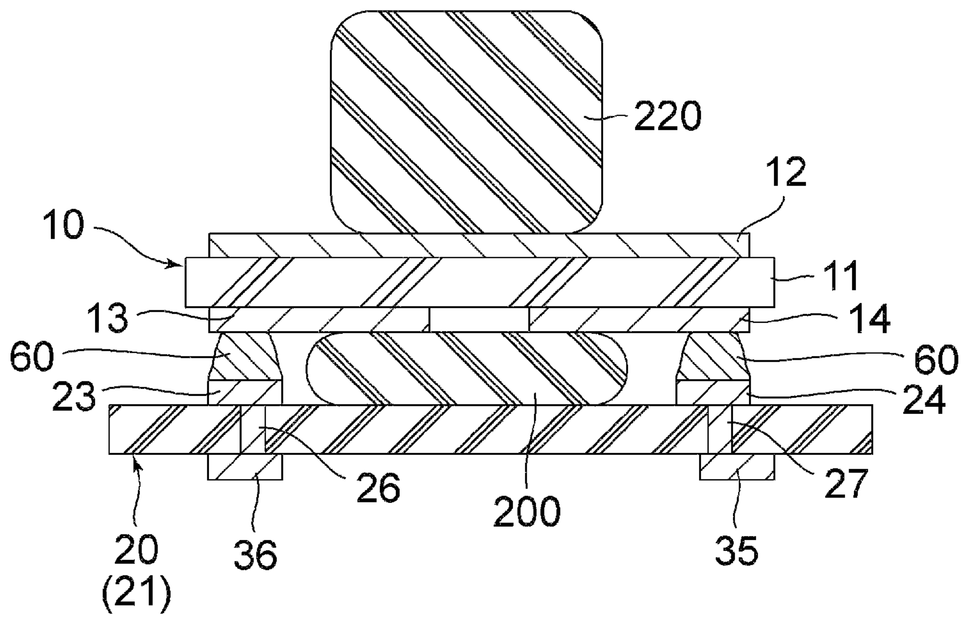


FIG. 7

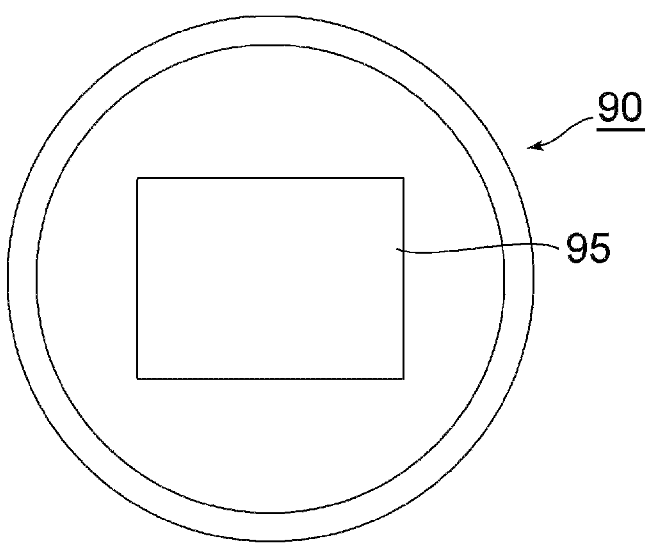


FIG. 8

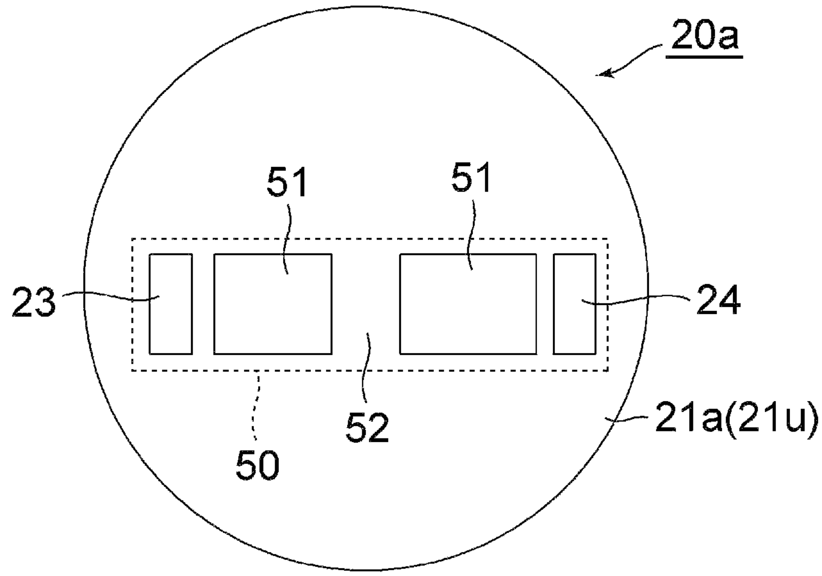

20a
51
51
23
24
21a(21u)
52
50

FIG. 9

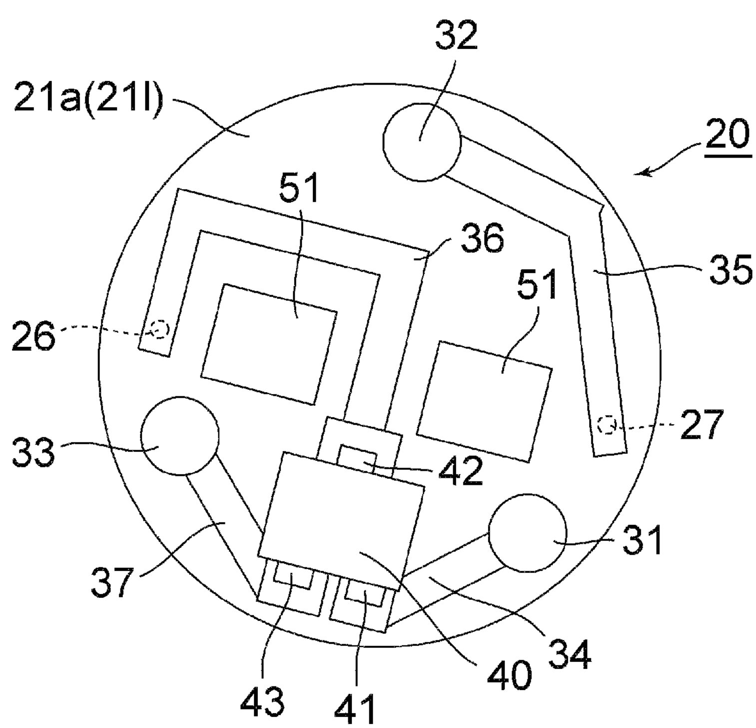

32
21a(21l)
20
51
36
35
51
26
27
33
42
31
37
34
40
43
41

FIG. 10

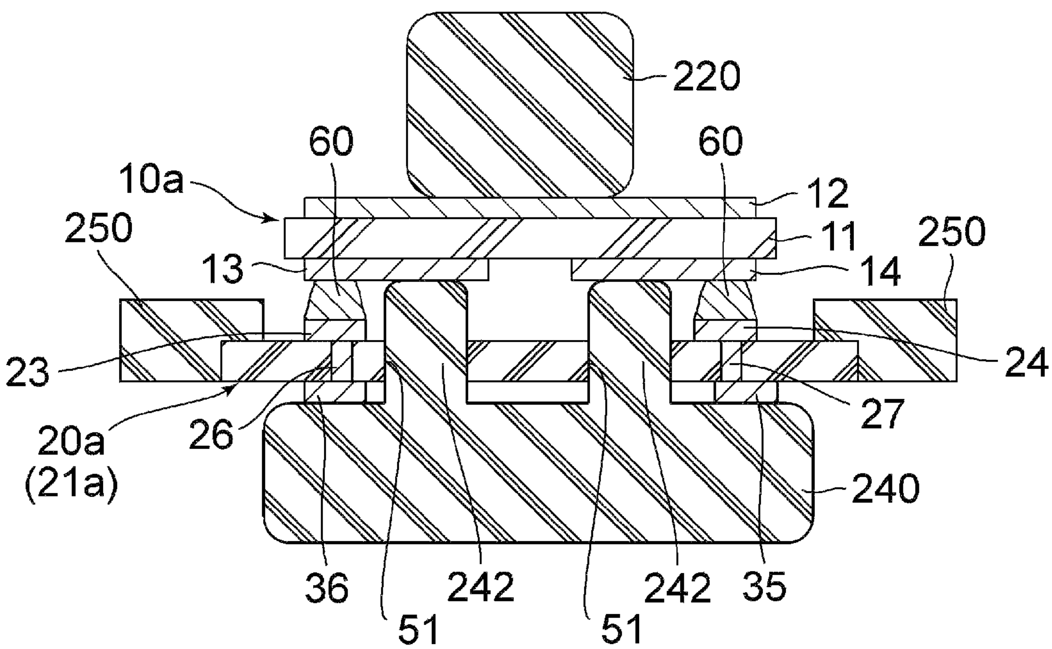

220
60
60
10a
12
11
250
250
13
14
23
24
27
20a
(21a)
26
240
36
242
242
35
51
51

FIG. 11

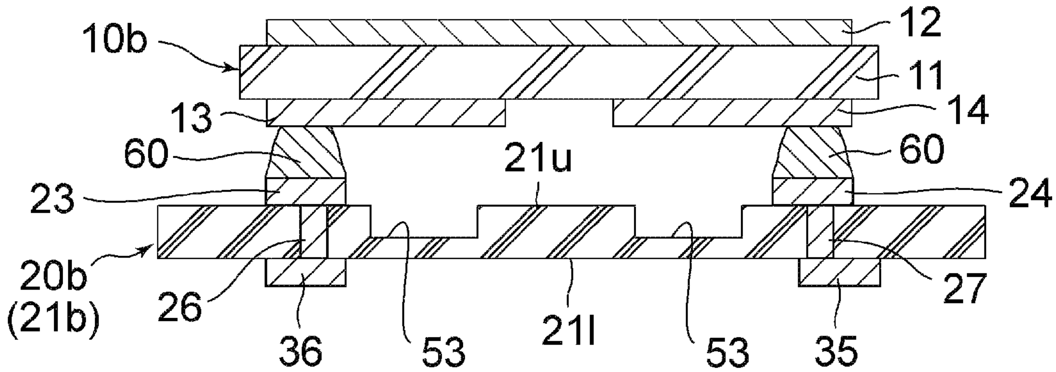
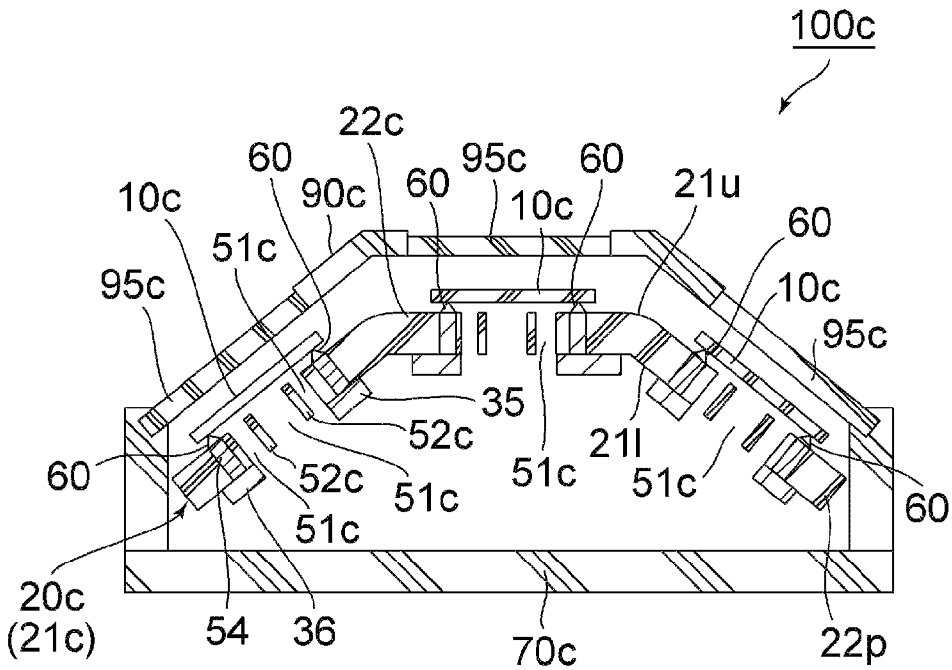
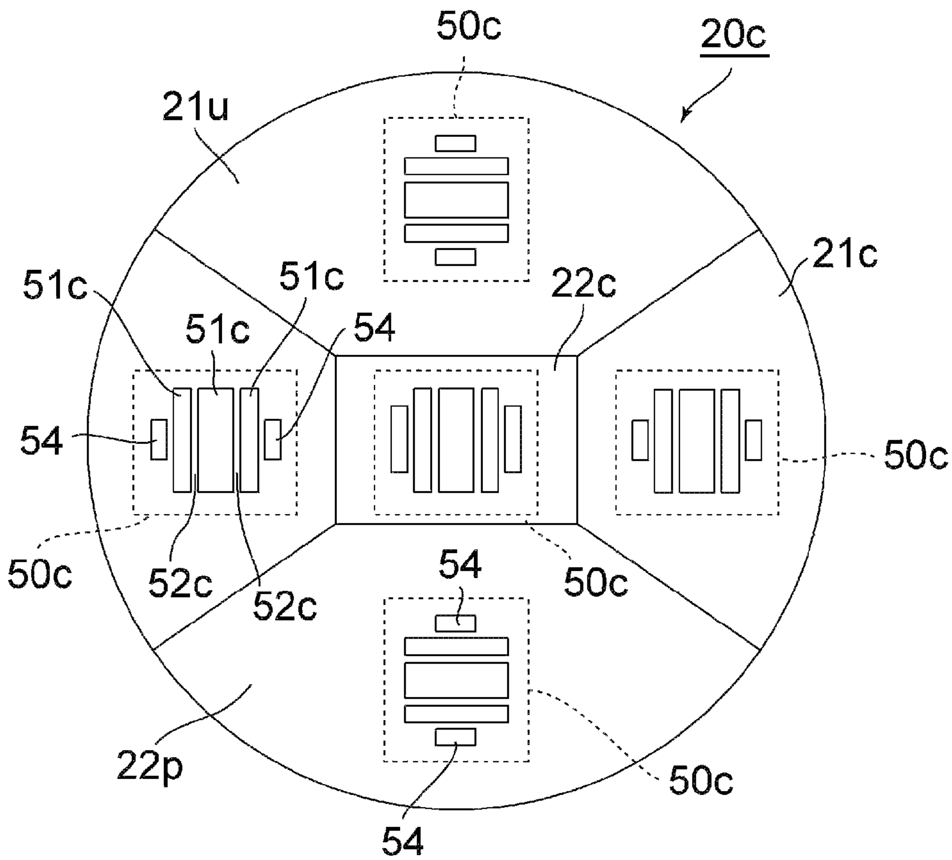

12
10b
11
13
14
60
60
21u
23
24
20b
(21b)
26
27
36
53
21l
53
35

FIG. 12



100c
22c
60
95c
60
60
10c
21u
90c
10c
60
51c
10c
95c
95c
35
52c
21l
60
51c
52c
51c
51c
60
51c
20c
(21c)
54
36
70c
22p

FIG. 13



50c
20c
21u
21c
51c
51c
22c
51c
54
54
50c
50c
52c
52c
50c
54
22p
50c
54

FIG. 14

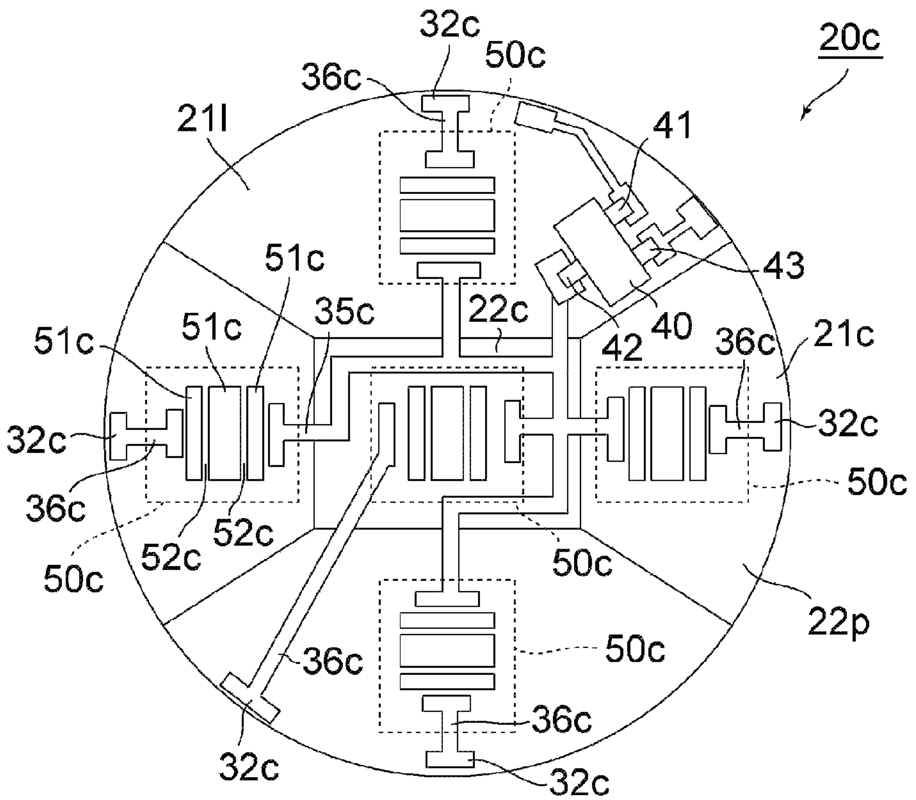

20c
32c
50c
36c
21l
41
43
51c
35c
22c
51c
51c
42
40
36c
21c
32c
32c
36c
50c
52c
52c
50c
50c
22p
36c
50c
36c
32c
32c

FIG. 15

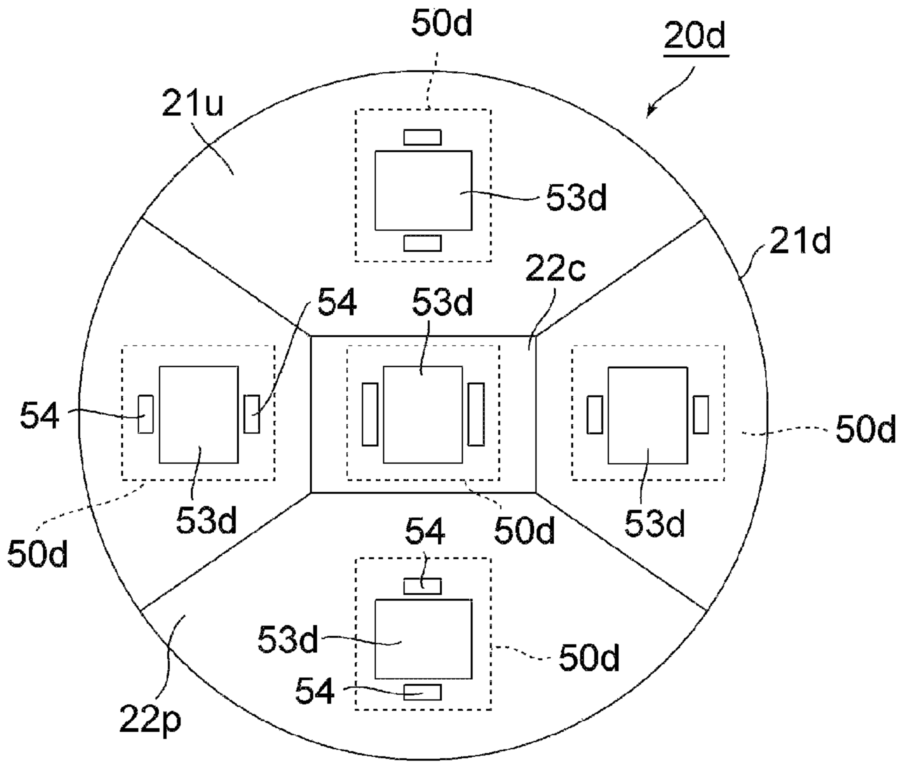
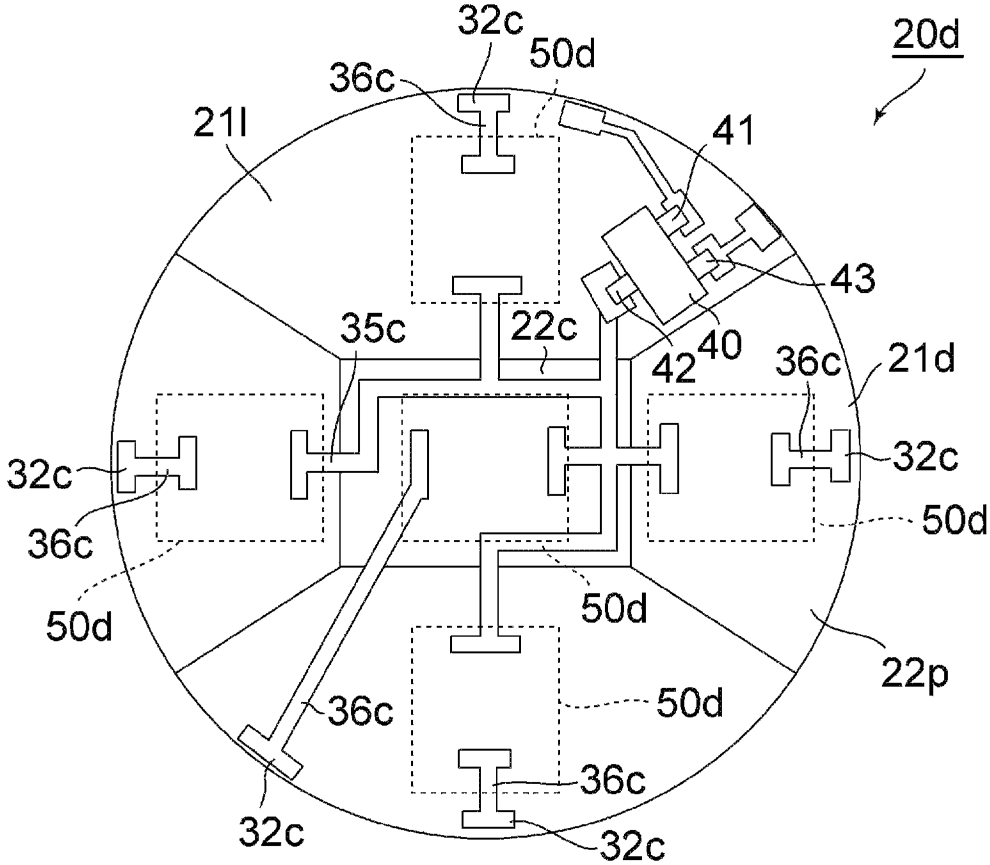

50d
20d
21u
53d
21d
22c
54
53d
54
50d
53d
50d
53d
50d
54
53d
50d
54
22p

FIG. 16


20d
32c
50d
36c
21l
41
43
35c
22c
42
40
36c
21d
32c
32c
36c
50d
50d
50d
22p
36c
50d
36c
32c
32c

PYROELECTRIC INFRARED DETECTING DEVICE, AND METHOD FOR REPLACING PYROELECTRIC ELEMENT IN PYROELECTRIC INFRARED DETECTING DEVICE

TECHNICAL FIELD

This invention relates to a pyroelectric type infrared detection device, in which a temperature detection element (pyroelectric element) with pyroelectric effect is mounted, and to a replacement method of a pyroelectric element in the pyroelectric type infrared detection device.

BACKGROUND ART

For example, Patent Document 1 discloses a pyroelectric type infrared detection device which includes a case member having two pyroelectric elements therein and two lenses condensing infrared lights into the two pyroelectric elements.

Patent Document 2 discloses a pyroelectric type infrared detection device with a structure where a pyroelectric element is mounted on a circuit board. In a pyroelectric type infrared detection device of Patent Document 2, electrodes of the pyroelectric element and other electrodes of the circuit board are electrically connected by hardened conductive adhesives. Hardness of the hardened conductive adhesive is 5 B to 6 B of pencil hardness. The hardened conductive adhesives used in Patent Document 2 are soft.

PRIOR ART DOCUMENTS

Patent Document(s)

Patent Document 1: JP 2008-268052 A
Patent Document 2: JP H 10-38679 A

DISCLOSURE OF INVENTION

Problems to be Solved by Invention

If a pyroelectric element included in a pyroelectric type infrared detection device is failed, the failed pyroelectric element should be replaced.

It is an object of the present invention to provide a pyroelectric type infrared detection device which allows easy replacement of a pyroelectric element.

Means for Solving the Problems

One aspect of the present invention provides a pyroelectric type infrared detection device which includes a pyroelectric element and an installation board. The pyroelectric element comprises a pyroelectric board formed of a plate-like pyroelectric member and element electrodes. The pyroelectric board has an upper surface and a lower surface. The upper surface of the pyroelectric board is a reception surface for receiving an infrared light. The lower surface of the pyroelectric board is formed with the element electrodes. The installation board has another upper surface which is provided with board electrodes. The element electrodes and the board electrodes are connected by hardened conductive adhesives. The conductive adhesives include epoxy resin. The hardened conductive adhesives have 4 B to 7 H, both inclusive, of pencil hardness as their hardness on JIS K 5600-5-4 (ISO 15184) standard basis.

Another aspect of the present invention provides a method of replacement of a pyroelectric element in the above-mentioned pyroelectric infrared detection device. The method comprises steps of: breaking the hardened conductive adhesives to take out the pyroelectric element; removing trace of the conductive adhesives from the board electrodes; and, while interposing new conductive adhesives between element electrodes of new pyroelectric element and the board electrodes, hardening the new conductive adhesives to electrically connected between the element electrodes of the new pyroelectric element and the board electrodes.

Advantageous Effect of Invention

The soft conductive adhesives of Patent Document 2 are much sticker so that it is difficult to take off the pyroelectric element from the circuit board. In addition, the difficulties might cause the board electrodes to be damaged or broken down upon taking off the pyroelectric element from the circuit board.

On the other hand, the hardened conductive adhesives of the present invention have 4 B to 7 H, both inclusive, of pencil hardness. Because of the hardness, impact load is locally applied to the hardened conductive adhesives so that intentional breakage and removal of the hardened conductive adhesives can be easily carried out. Therefore, upon replacement of the pyroelectric element, the pyroelectric element can be taken off without applying undesirable damage to the pyroelectric type infrared detection device.

An appreciation of the objectives of the present invention and a more complete understanding of its structure may be had by studying the following description of the preferred embodiment and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is an exploded, side view showing a pyroelectric type infrared detection device according to a first embodiment of the present invention.

FIG. **2** is a top plan view showing a pyroelectric element included in the pyroelectric type infrared detection device of FIG. **1**.

FIG. **3** is a bottom view showing a pyroelectric element of FIG. **2**.

FIG. **4** is a top plan view showing an installation board included in the pyroelectric type infrared detection device of FIG. **1**.

FIG. **5** is a bottom view showing the installation board of FIG. **4**.

FIG. **6** is a view showing a process for installing the pyroelectric element on the installation board. This view illustrates its cross-section only.

FIG. **7** is a top plan view showing a package of FIG. **1**.

FIG. **8** is a top plan view showing an installation board included in a pyroelectric type infrared detection device according to a second embodiment of the present invention.

FIG. **9** is a bottom view showing the installation board of FIG. **8**.

FIG. **10** is a cross-sectional view showing a process for installing the pyroelectric element on the installation board.

FIG. **11** is a cross-sectional view showing a modification of the pyroelectric type infrared detection device of FIG. **8**. Especially, this view illustrates a relation between the installation board and the pyroelectric element.

FIG. **12** is a view showing a pyroelectric type infrared detection device according to a third embodiment of the present invention. This view illustrates its cross-section only.

FIG. **13** is a top plan view showing an installation board included in the pyroelectric type infrared detection device of FIG. **12**.

FIG. **14** is a bottom view showing the installation board of FIG. **13**.

FIG. **15** is a top plan view showing a modification of the installation board of FIG. **12**.

FIG. **16** is a bottom view showing the installation board of FIG. **15**.

BEST MODE FOR CARRYING OUT INVENTION

While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings and will herein be described in detail. It should be understood, however, that the drawings and detailed description thereto are not intended to limit the invention to the particular form disclosed, but on the contrary, the intention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the present invention as defined by the appended claims.

[First Embodiment]

With reference to FIG. **1**, a pyroelectric type infrared detection device **100** according to a first embodiment of the present invention comprises a pyroelectric element **10** and an installation board **20** as well as a base **70** and a package **90**, wherein the pyroelectric element **10** is installed on the installation board **20**, the base **70** and the package **90** accommodate the pyroelectric element **10** and the installation board **20**.

As shown in FIGS. **1** to **3**, the pyroelectric element **10** according to the present embodiment is an element of dual-type and comprises a pyroelectric board **11**, an upper electrode **12** and two lower electrodes (element electrodes) **13**, **14**, wherein the pyroelectric board **11** has a rectangular shape and is formed of a pyroelectric member, the upper electrode **12** is formed on an upper surface **11***u* of the pyroelectric board **11**, and the lower electrodes **13**, **14** are formed on a lower surface **11***l* of the pyroelectric board **11**. Each of the lower electrodes **13**, **14** has a quadrate conductive pattern and covers almost left half or right half of the lower surface **11***l*. The upper electrode **12** has two quadrate conductive patterns and another conductive pattern couple therebetween, wherein the quadrate conductive patterns correspond to the lower electrodes **13**, **14**. The pyroelectric board **11** is subjected to a polarization process by applying voltage between the upper electrode **12** and the lower electrodes **13**, **14** before installation of the pyroelectric board **11** to the installation board **20**. When the pyroelectric board **11** absorbs infrared lights, electric charges appear on a surface of the pyroelectric board **11**, depending on temperature variation due to the absorption. Therefore, monitoring a voltage variation between the upper electrode **12** and the lower electrodes **13**, **14** can detect infrared lights.

The installation board **20** includes a substrate **21**, two upper electrodes (board electrodes) **23**, **24**, lower electrodes **31**, **32**, **33** and conductive traces **34**, **35**, **36**, **37**, wherein the substrate **21** is made of insulator, the upper electrodes **23**, **24** are formed on an upper surface **21***u* of the substrate **21**, and the lower electrodes **31**, **32**, **33** as well as the conductive traces **34**, **35**, **36**, **37** are formed on a lower surface **21***l* of the substrate **21**. On the lower surface **21***l* of the substrate **21**, a field effect transistor (semiconductor amplifier element) **40** is installed. A drain **41** of the field effect transistor **40** is connected to the lower electrode **31** through the conductive trace **34**. A gate **42** of the field effect transistor **40** is connected to the upper electrode **23** through the conductive trace **36** and a through-hole **26** piercing the substrate **21**. A source **43** of the field effect transistor **40** is connected to the lower electrode **33** through the conductive trace **37**. The lower electrode **32** is connected to the upper electrode **24** through the conductive trace **35** and a through-hole **27** piercing the substrate **21**.

As understood from FIGS. **1**, **3** and **4**, the upper electrodes **23**, **24** of the installation board **20** and the lower electrodes **13**, **14** of the pyroelectric element **10** are connected by using hardened conductive adhesives **60**. The conductive adhesives **60** include epoxy resin and, after hardened, have 4 B to 7 H, both inclusive, of pencil hardness as their hardness on JIS K 5600-5-4 (ISO 15184) standard basis. In other words, they are harder in comparison with the conductive adhesives of Patent Document 2. For materials, and so on, of the conductive adhesives **60**, detail explanation will be made afterwards.

Specifically, the connection with the conductive adhesives **60** are carried out as shown in FIG. **6**. First, a spacer **200** is disposed between the upper electrode **23** and the upper electrode **24** of the installation board **20**. Next, the conductive adhesives **60** are applied on the upper electrode **23** and the upper electrode **24**. Furthermore, the pyroelectric element **10** is arranged above the installation board **20** so that the upper electrodes **23**, **24** of the installation board **20** and the lower electrodes **13**, **14** of the pyroelectric element **10** face each other in a vertical direction. While the conductive adhesives **60** are interposed between the upper electrodes **23**, **24** of the installation board **20** and the lower electrodes **13**, **14** of the pyroelectric element **10**, a weight **220** is put on the pyroelectric element **10**. In detail, the weight **220** is put so that the weight **220** does not protrude from the spacer **200** as viewed transparently of the pyroelectric element **10** from above. Under this condition, the conductive adhesives **60** are hardened through heat treatment, and then the weight **220** and the spacer **200** are removed, so that the installation of the pyroelectric element **10** onto the installation board **20** is completed. As understood from this structure, the pyroelectric element **10** and the installation board **20** are connected to each other only by the conductive adhesives **60**, and they are substantially isolated in thermal aspect from each other.

To the lower electrodes **31**, **32**, **33** of the installation board **20**, external connection pins **81**, **82**, **83** are connected, respectively, by using conductive adhesives such as solder or the like. The installation board **20** is installed on the base **70** so that the external connection pins **81**, **82**, **83** pierce the base **70**. Under inert gas atmosphere, the package **90** and the base **70** are sealed. The reason of sealing under inert gas atmosphere is to prevent humidity from causing variation of characteristics of the pyroelectric element **10** and deterioration of the pyroelectric element **10** as such. Thus, the pyroelectric element **10** and the installation board **20** are accommodated within a space formed between the package **90** and the base **70**.

As understood from FIG. **7**, an optical filter **95** is attached to a center of the upper surface of the package **90**, which allows only infrared lights with desired wavelengths to enter into the package **90**, depending upon its use such as human detection.

In the pyroelectric type infrared detection device **100** with the above-mentioned structure, the lower electrode **13** of the pyroelectric element **10** is electrically connected to the gate **42** of the field effect transistor **40**, the lower electrode **14** of the pyroelectric element **10** is electrically connected to the external connection pin **82**, the drain **41** of the field effect transistor **40** is electrically connected to the external connection pin **81**, and the source **43** of the field effect transistor **40** is electrically connected to the external connection pin **83**. Between the drain **41** and the source **43**, a suitable voltage is applied.

In the above-mentioned pyroelectric type infrared detection device **100**, entering of infrared lights into the pyroelectric element **10** excites electric charges on one of the lower electrodes **13**, **14** of the pyroelectric element **10** so that a voltage caused by the electric charges is applied to the gate **42**. Thus, the infrared lights can be detected. On the other hand, if temperature variation, and so on, excites electric charges on the whole pyroelectric element **10**, the same voltages appear on the lower electrode **13** and the lower electrode **14** as each other so that the output of the pyroelectric type infrared detection device **100** is not detected. If a high resistance is electrically connected between the gate **42** and the upper electrode **23**, the pyroelectric type infrared detection device **100** does not detect undesirable output due to temperature difference within the pyroelectric element **10**. To detect human movement, resistance will be set so that its output can be detected at a frequency of about 1 Hz.

As described above, the conductive adhesives **60** according to the present embodiment include epoxy resin and, after hardened, have 4 B to 7 H, both inclusive, of pencil hardness as their hardness on JIS K 5600-5-4 (ISO 15184) standard basis. Use of the aforementioned conductive adhesives **60** allows that, if the pyroelectric element **10** fails, the failing pyroelectric element **10** can be easily taken off by opening the package **90**, followed by cutting the conductive adhesives **60** literally by the use of cutter. Furthermore, trace of the conductive adhesives **60** on the upper electrodes **23**, **24** of the installation board **20** can be completely removed by pressing with the cutter.

For example, a mixture of an adhesive agent and conductive particles can be used as the aforementioned conductive adhesives **60**. As the adhesive agent, a mixture of epoxy resin and hardener or a silicone resin may be used, wherein the epoxy resin is, for example, bisphenol A epoxy resin, bisphenol F epoxy resin or phenol novolac epoxy resin, and the hardener is, for example, an imidazole-based one. As the conductive particles, metal powder particles of copper, silver, nickel, and so on, as well as resin or ceramic powder particles coated with the aforementioned metal may be used. The conductive particles may have various shapes such us a scale shape, a spherical shape and a granular shape.

Especially, the conductive adhesive **60** according to the present embodiment is a mixture of an adhesive agent of about 20 to 40 weight % and conductive particles of about 60 to 80 weight % and, as mentioned above, has 4 B to 7 H, both inclusive, of pencil hardness as its hardness on JIS K 5600-5-4 (ISO 15184) standard basis after hardened. For example, if conductive adhesives “3301”, “3301B”, “3301 N” manufactured by ThreeBond Co., Ltd. as well as conductive adhesives “CE-3920” manufactured by Emerson & Cuming are thermoset under the condition of 150 C.°×30 minutes, they have 4 B to 7 H, both inclusive, of pencil hardness as their hardness after hardened. On the other hand, if conductive adhesives “3302”, “3302B” manufactured by ThreeBond Co., Ltd. are thermoset under the condition of 150° C.×30 minutes, they have their hardness smaller than 4 B of pencil hardness as after hardened.

It is preferable that the conductive adhesives **60** has 3.0 to 3.7, both inclusive, of thixotropy index or structural viscosity ratio, wherein thixotropy index $=\eta 1(0.5\text{ rpm}, 25°\text{ C.})/\eta 2(5.0\text{ rpm}, 25°\text{ C.})$. If thixotropy index is thus set, a distance between the pyroelectric element **10** and the installation board **20** can be made 0.2 mm or more. Therefore, workability upon removal of the failing pyroelectric element can be improved. In addition, heat transfer due to heat radiation between the pyroelectric element **10** and the installation board **20** can be prevented. Therefore, responsivity of the pyroelectric element **10** for incoming infrared lights can be improved.

Furthermore, it is preferable that conductive adhesives meeting the following condition is selected as the conductive adhesives **60**: a difference between thermal expansion coefficient of the conductive adhesives **60** and thermal expansion coefficient of the pyroelectric board **11** is 10% or less of the thermal expansion coefficient of the pyroelectric board **11**. If such conductive adhesives **60** are used, stress due to thermal variation can be suppressed.

If human detection is carried out for crime prevention or power saving, a frequency band of signals is around 1 Hz. If a popcorn noise is detected upon such use, the popcorn noise is in a form of pulse which has a width of several milliseconds. Such undesirable popcorn noise can be removed by the use of band-pass filter. However, the hardness of the conductive adhesive **60** after hardened is 7 H or smaller of pencil hardness as in the present embodiment, a popcorn noise is so small that it is hardly recognized.

Although the conductive adhesives **60** are pressed and fixed by the spacer **200** and the weight **220** as shown in FIG. **6** while the conductive adhesives **60** are completely thermoset in the above-mentioned embodiment, the present invention is not limited thereto. For example, the conductive adhesives **60** are pressed and fixed by the spacer **200** and the weight **220** as shown in FIG. **6** while the conductive adhesives **60** are provisionally thermoset under the temperature of around 60° C. Then, the spacer **200** and the weight **220** are removed so that the conductive adhesives **60** are completely hardened. Namely, multi-step curing may be carried out so that stress within the conductive adhesives **60** is relaxed.

[Second Embodiment]

A pyroelectric type infrared detection device according to a second embodiment of the present invention is a modification of the pyroelectric type infrared detection device **100** according to the aforementioned first embodiment. Hereinafter, explanation will be directed only to its difference from the first embodiment with reference to drawings.

The pyroelectric type infrared detection device according to the present embodiment comprises an installation board **20***a* as shown in FIGS. **8** to **10**. The installation board **20***a* is generally same as the installation board **20** of the first embodiment (See FIGS. **8** and **9**) except that the installation board **20***a* is formed with two piercing-holes **51**.

In detail, the piercing-holes **51** are formed within a correspondence region **50** which is a region corresponding to the pyroelectric element **10** in the installation board **20***a*. In addition, the upper electrodes **23**, **24** are located within the correspondence region **50**, too. Furthermore, the number of the provided piercing-holes **51** is not one but two, i.e., plural. Between the piercing-holes **51**, a beam portion **52** is positioned. The existence of the beam portion **52** enables the installation board **20***a* to ensure its strength in comparison with the case of formation of a large piercing-hole **51**.

The aforementioned provision of the piercing-holes within the correspondence region **50** makes an area size small, wherein the area size is of the installation board **20***a* facing the pyroelectric element **10** when the pyroelectric element **10** is installed on the installation board **20***a*. Therefore, heat transfer due to heat radiation from the pyroelectric element **10** to the installation board **20***a* can be prevented while heat transfer due to heat radiation to the installation board **20** from the pyroelectric element **10** can be prevented. Thus, according to the present embodiment, responsivity of the pyroelectric element **10** for incoming infrared lights can be improved.

In the pyroelectric type infrared detection device **100** according to the aforementioned first embodiment, the spacer **200** is interposed between the pyroelectric element **10** and the installation board **20** upon the hardening of the conductive adhesives **60** (See FIG. **6**). On the other hand, the pyroelectric element **10** is installed on the installation board **20***a* through a different method in the pyroelectric type infrared detection device according to the present embodiment.

Specifically, as shown in FIG. **10**, a positioner **240**, a control plate **250** and a weight **220** are used, wherein the positioner **240** has two support portions **242** projecting upwards. While the control plate **250** controls edge portions or peripheral portions of the installation board **20***a* to prevent upward or horizontal movement thereof, the support portions **242** are inserted into the piercing-holes **51**, respectively, so that tips or upper ends of the support portions **242** support the lower electrodes **13**, **14**, respectively. Thus, the positioning of the pyroelectric element **10** for the installation board **20***a* is carried out. Under this state, the weight **220** is put on the upper electrode **12** of the pyroelectric element **10** while the conductive adhesives **60** are thermoset, so that the pyroelectric element **10** is installed on the installation board **20***a*. Use of the control plate **250** can prevent rising of the installation board **20***a*. In addition, even if the conductive adhesives **60** are hardened and shrunk, the positioner **240** can be taken off. Therefore, according to the present embodiment, the conductive adhesives **60** with high cure shrinkage can be used.

In addition, if heat transfer due to heat radiation will be prevented although installation method may be same as that of the first embodiment, a substrate **21***b* of an installation board **20***b* may be formed with depression portions **53** instead of the piercing-holes **51**, as shown in FIG. **11**. The depression portions **53** are formed in correspondence regions corresponding to the pyroelectric element **10***b* and are depressed downwards from the upper surface **21***u* of the substrate **21***b*. The structure reduces regions of the pyroelectric element **10** and the installation board **20***b* facing each other with the minimum distance therebetween, in comparison with that of the first embodiment, so that undesirable heat transfer can be prevented.

[Third Embodiment]

With reference to FIGS. **12** to **14**, a pyroelectric type infrared detection device **100***c* according to a third embodiment of the present invention is a further modification of the pyroelectric type infrared detection device according to the aforementioned second embodiment. Hereinafter, explanation will be directed only to its difference between the above-mentioned embodiment and the present embodiment, with reference to drawings.

As shown in FIGS. **12** to **14**, a plurality of pyroelectric elements **10***c* are installed on a single installation board **20***c* in this embodiment.

As apparent from FIG. **12**, the installation board **20***c* has a peripheral section **22***p* and a central section **22***c* and has a shape that the central section **22***c* is raised from the peripheral section **22***p*. Specifically, the installation board **20***c* has a domical shape that the central section is swelled upwards.

As understood from FIGS. **12** to **14**, on the installation board **20***c* according to the present embodiment, five pyroelectric elements **10***c* are installed. As shown in FIGS. **13** and **14**, each of correspondence regions **50***c* corresponding to the respective pyroelectric elements **10***c* is formed with three, i.e. plural, piercing-holes **51***c*, and a beam portion **52***c* is provided between the piercing-holes **51***c* in each correspondence region **50***c*. Therefore, undesirable heat transfer between the installation board **20***c* and each pyroelectric element **10***c* can be prevented without unintentional degradation of the strength of the installation board **20***c*.

In the present embodiment, electrodes or traces formed on an upper surface **21***u* of a substrate **21***c* and electrodes or traces formed on a lower surface **21***l* of the substrate **21***c* are connected to each other with conductive members **54**. The conductive members **54** according to the present embodiment are disposed within the substrate **21** upon the molding of the substrate **21** via insert-molding process. However, the present invention is not limited thereto. For example, the conductive members **54** may be constituted by through holes or via holes.

As shown in FIG. **14**, a field effect transistor **40** is provided on the lower surface **21***l* of the substrate **21**. As apparent from drawings, one of the electrodes positioned on each correspondence region **50***c*, which corresponds to one of the element electrodes of each pyroelectric element **10***c*, is electrically connected to a gate **42** of the field effect transistor **40** through a conductive trace **35***c*. the other one of the electrodes positioned on each correspondence region **50***c*, which corresponds to the other one of the element electrodes of each pyroelectric element **10***c*, is connected to a corresponding lower electrode **32***c* through a corresponding conductive trace **36***c*. Namely, one of the electrodes of the pyroelectric elements **10***c* is connected to the common gate **42**. Furthermore, the lower electrodes **32***c* are connected to each other through members not shown. The structure enables that, when infrared lights enter any one of the pyroelectric elements **10***c*, the entering can be detected. In addition, the conductive traces and the electrodes on the installation board **20***c* may be formed through a molded interconnect device (MID) technology.

As shown in FIG. **12**, a package **90***c* has a domical shape in correspondence with the shape of the installation board **20***c*. A space formed between the package **90***c* and a base **70***c* accommodates the above-mentioned installation board **20***c* and the pyroelectric elements **10***c*, while the package **90***c* and the base **70***c* are sealed off. The package **90***c* is provided with an optical filter **95***c* in correspondence with the pyroelectric elements **10***c*.

The pyroelectric type infrared detection device **100***c* with the aforementioned structure has no need of condenser lenses which are used for widening its viewing angle in Patent Document 1. In addition, if each one of the pyroelectric elements **10***c* should be replaced, the other pyroelectric elements **10***c* are out of the replacement so that the workability upon replacement of the pyroelectric elements **10***c* is thus improved.

Similar to the above-mentioned second embodiment, the present embodiment can be modified so that its piercing-holes are replaced with depression portions. Specifically, as shown in FIGS. **15** and **16**, an installation board **20***d* may be formed not with piercing-holes but with depression portions **53***d*. The depression portions **53***d* are depressed from an upper surface **21***u* toward a lower surface **21***l* of a substrate **21***d* in correspondence regions **50***d*, respectively. Because the depression portions **53***d* do not pierce the substrate **21***d*, the depression portions **53***d* are not shown in FIG. **16**.

In every embodiments mentioned above, the connection between the pyroelectric element and the installation board uses the conductive adhesives **60** which include epoxy resin and have 4 B to 7 H, both inclusive, of pencil hardness as their hardness. Therefore, replacement of the pyroelectric element becomes easier.

The present application is based on a Japanese patent application of JP2010-213760 filed before the Japan Patent Office on Sep. 24, 2010, the contents of which are incorporated herein by reference.

While there has been described what is believed to be the preferred embodiment of the invention, those skilled in the art will recognize that other and further modifications may be made thereto without departing from the spirit of the invention, and it is intended to claim all such embodiments that fall within the true scope of the invention.

DESCRIPTION OF NUMERALS

10,**10***a*, **10***b*, **10***c* Pyroelectric element
11 Pyroelectric board
11*u* Upper Surface
11*l* Lower Surface
12 Upper Electrode
13, **14** Lower Electrode (Element Electrode)
20, **20***a*, **20***b*, **20***c*, **20***d* Installation Board
21, **21***a*, **21***b*, **21***c*, **21***d* Substrate
21*u* Upper Surface
21*l* Lower Surface
22*p* Peripheral Section
22*c* Central Section
23, **24** Upper Electrode (Board Electrode)
26, **27** Through-hole
31, **32**, **32***c*, **33** Lower Electrode
34, **35**, **35***c*, **36**, **36***c*, **37** Conductive Trace
40 Field Effect Transistor (Semiconductor Amplifier Element)
41 Drain
42 Gate
43 Source
50, **50***c*, **50***d* Correspondence Region
51, **51***c* Piercing-hole
52, **52***c* Beam Portion
53, **53***d* Depression Portion
54 Conductive Member
60 Conductive Adhesive
70 Base
81, **82**, **83** External Connection Pin
90, **90***c* Package
95, **95***c* Optical Filter
100, **100***c* Pyroelectric Type Infrared Detection Device
200 Spacer
220 Weight
240 Positioner
242 Support Portion
250 Control Plate

The invention claimed is:

1. A pyroelectric infrared detection device comprising:
a pyroelectric element; and
an installation board,
wherein:
the pyroelectric element comprises a pyroelectric board formed of a plate-like pyroelectric member and element electrodes;
the pyroelectric board has an upper surface and a lower surface;
the upper surface of the pyroelectric board is a reception surface for receiving an infrared light;
the element electrodes are formed on the lower surface of the pyroelectric board;
the installation board includes a substrate having an upper surface and a lower surface and board electrodes;
the board electrodes are formed on the upper surface of the substrate;
the element electrodes and the board electrodes are connected by a hardened conductive adhesive;

the hardened conductive adhesive is made of a mixture of an epoxy resin and an imidazole-based hardener or a silicone resin, whereon the epoxy resin is a bisphenol A epoxy resin, a bisphenol F epoxy resin or a phenol novolac epoxy resin; and
the hardened conductive adhesive has a pencil hardness of 4B to 7H, based on JIS k 5600-5-4 (ISO 15184).

2. The pyroelectric infrared detection device as recited in claim **1**, wherein the installation board has a peripheral section and a central section; and wherein the central section is swelled upwards in comparison with the peripheral section.

3. The pyroelectric infrared detection device as recited in claim **1**, wherein:
the installation board has a correspondence region corresponding to the pyroelectric element;
the board electrodes are formed within the correspondence region; and
the correspondence region is formed with piercing-holes piercing the installation board.

4. The pyroelectric infrared detection device as recited in claim **3**, wherein:
a plurality of the piercing-holes are formed within the correspondence region; and
a beam portion is provided between the piercing-holes in the correspondence region.

5. The pyroelectric infrared detection device as recited in claim **1**, wherein:
the installation board has a correspondence region corresponding to the pyroelectric element;
the board electrodes are formed within the correspondence region; and
the correspondence region is formed with a depression portion depressed downwards.

6. The pyroelectric infrared detection device as recited in claim **1**, further comprising a semiconductor amplifier element,
wherein the semiconductor amplifier element is installed on the lower surface of the substrate, the lower surface of the substrate being a back side of the upper surface of the substrate; and
one of the board electrodes is coupled to the semiconductor amplifier element.

7. A method for replacing the pyroelectric element in the pyroelectric infrared detection device as recited in claim **1**, the method comprising:
breaking the hardened conductive adhesive to take off the pyroelectric element;
removing trace amounts of the hardened conductive adhesive from the board electrodes; and
while interposing a new conductive adhesive between element electrodes of a new pyroelectric element and the board electrodes, hardening the new conductive adhesive to electrically connect the element electrodes of the new pyroelectric element and the board electrodes.

8. A method for replacing a pyroelectric element in a pyroelectric infrared detection device, the pyroelectric type infrared detection device comprising a pyroelectric element and an installation board, wherein:
the pyroelectric element comprises a pyroelectric board formed of a plate-like pyroelectric member and element electrodes;
the pyroelectric board has an upper surface and a lower surface;
the upper surface of the pyroelectric board is a reception surface for receiving an infrared light;
the element electrodes are formed on the lower surface of the pyroelectric board;

the installation board includes a substrate having an upper surface and a lower surface and board electrodes;

the board electrodes are formed on the upper surface of the substrate;

the element electrodes and the board electrodes are connected by a hardened conductive adhesive;

the hardened conductive adhesive includes an epoxy resin; and

the hardened conductive adhesive has a pencil hardness of 4B to 7H, based on JIS k 5600-5-4(ISO 15184), the method comprising:

breaking the hardened conductive adhesive to take off the pyroelectric element;

removing trace amounts of the hardened conductive adhesive from the board electrodes; and

while interposing a new conductive adhesive between element electrodes of a new pyroelectric element and the board electrodes, hardening the new conductive adhesive to electrically connect the element electrodes of the new pyroelectric element and the board electrodes.

* * * * *